SEMICONDUCTOR DEVICE AND METHOD OF FABRICATING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates to a semiconductor device and a method of fabricating the semiconductor device. More particularly, the present invention relates to a thin semiconductor device permitting high-density packaging, and a method of fabricating the semiconductor device.

2. Description of the Related Art:

A conventional semiconductor device is constructed by fixing a semiconductor IC chip to a wiring substrate with an adhesive, electrically connecting bond pads of the semiconductor IC chip to bond pads formed on the wiring substrate with metal wires, and sealing the semiconductor IC chip and the metal wires in a resin for protection.

When fabricating this conventional semiconductor device, the semiconductor IC chip is fixed to the wiring substrate with the adhesive, the bond pads of the semiconductor IC chip are connected electrically to the bond pads of the wiring substrate with metal wires, and the semiconductor IC chip and the metal wires are covered with and sealed in the resin.

The conventional technique, however, has the following problems. The respective thickness of the semiconductor IC chip and the layer of the adhesive bonding the semiconductor IC chip to the wiring substrate are included in the thickness of the semiconductor device, which makes it difficult to form the semiconductor device in a small thickness.

The area of the layer of the adhesive is greater than that of the semiconductor IC chip, and the layer of the adhesive spreads in an unpredictable shape when compressed between the semiconductor IC chip and the wiring substrate. Therefore, the bond pads of the wiring substrate to which the bond pads of the semiconductor IC chip are to be connected by the metal wires must be spaced from the periphery of the semiconductor IC chip by, for example, 8 mm or above, which makes high-density packaging difficult.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a thin semiconductor device permitting high-density packaging.

With the foregoing object in view, the present invention provides a semiconductor device comprising a semiconductor IC chip provided on its first surface with bond pads; a wiring substrate provided with a through hole extending between its first surface and its second surfaces opposed to the first surface; conductive members electrically connecting the bond pads of the semiconductor IC chip to conductive lines formed on the wiring substrate; and a resin molding covering the surface of the semiconductor IC chip and fixing side surface of the semiconductor IC chip to side surface of the through hole.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention, it is believed that the invention, the objects and features of the invention and further objects, features and advantages thereof will be better understood from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a sectional view of a semiconductor device in a first embodiment according to the present invention;

Figs. 2(a) to 2(e) are typical sectional views of assistance in explaining a method of fabricating the semiconductor device in the first embodiment;

Figs. 3(a) to 3(d) are typical sectional views of assistance in explaining another method of fabricating the semiconductor device in the first embodiment;

Fig. 4 is a typical sectional view of assistance in explaining a method of forming wires by using a conductive paste;

Figs. 5(a) to 5(c) are typical sectional views of assistance in explaining a method of forming wires by using a conductive paste;

Figs. 6(a) to 6(d) are typical sectional views of assistance in explaining a method of forming wires by using a conductive paste; and

Fig. 7 is a typical sectional view of a semiconductor device in a second embodiment according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

First Embodiment

Referring to Fig. 1, a semiconductor device in a first embodiment according to the present invention comprises a semiconductor IC chip 1 provided on its front surface with bond pads, a wiring substrate 2 provided with a through hole, metal wires 3, and a sealing resin coating 4. The metal wires 3 are extended in a shape of a height 5. The sealing resin coating 4 has a height 6. The back surface of the semiconductor IC chip 1 is spaced a distance 7 apart form the back surface of the wiring substrate 2.

Referring to Fig. 1, the semiconductor IC chip 1 is inserted in the through hole of the wiring substrate 2, and the bond pads of the semiconductor IC chip 1 are connected electrically to the bond pads formed at the edge of the conductive lines of the wiring substrate 2 by the metal wires 3. The sealing resin coating molding 4 coats the semiconductor IC chip 1 and the metal wires 3. Part of the sealing resin coating 4 fills up gaps between the side surface of the semiconductor IC chip 1 and the side surface of the through hole of the wiring substrate 2 to bond the semiconductor IC chip 1 to the wiring substrate 2.

The height 5 of the metal wires 3 is in the range of 150 to 250 μ m, and hence the thickness 6 of the sealing resin coating 6 is in the range of 170 to 270 μ m. The thickness 6 is 270 μ m at the

greatest. The sealing resin coating 4 may possibly flow through the gaps between the side surface of the semiconductor IC chip 1 and the side surface of the through hole of the wiring substrate 2 onto the back surface of the semiconductor IC chip 1. Therefore, the back surface of the semiconductor IC chip 1 is spaced from the back surface of the wiring substrate 2 by the distance 7 of 50 μ m or above. If the sealing resin coating 4 flowed onto the back surface of the semiconductor IC chip 1 is removed later, the back surface of the semiconductor IC chip 1 may be flush with the back surface of the wiring substrate 2, i.e., the distance 7 may be naught.

Since the semiconductor IC chip 1 is inserted in the through hole of the wiring substrate 2, the thickness 6 of the sealing resin coating 4 is dependent substantially only on the height 5 of the metal wires 3 and is smaller than that of the sealing resin coating of the corresponding conventional semiconductor device.

Thus, the semiconductor device of the present invention can be formed in a small thickness.

Since the semiconductor IC chip 1 is inserted in the through hole of the wiring substrate 2, the length of the metal wires 3 is shorter than that of corresponding conventional semiconductor and hence the total resistance of the metal wires 3 can decrease.

Since the semiconductor IC chip 1 is inserted in the through hole of the wiring substrate 2, the semiconductor IC chip 1 can be attached to the wiring substrate 2 with its front surface substantially flush with the front surface of the wiring substrate 2 and hence the faulty coating of the semiconductor IC chip 1 and the metal wires 3 with the sealing resin coating attributable to steps between the semiconductor IC chip 1 and the wiring substrate 2 will rarely occur. Since any adhesive is not used for attaching the semiconductor IC chip 1 to the wiring substrate 2, the bond pads of the wiring substrate 2 need not be separated far from the edges of the semiconductor IC chip 1 to avoid being covered with an irregularly spread layer of an adhesive. The distance between the edges of the semiconductor IC chip 1 and the bond pads of the wiring substrate 2 may be about 0.3 mm. Accordingly, the sealing resin coating 4 can be formed in a small area, which enables high-density packaging.

Since the semiconductor IC chip 1 is attached to the wiring substrate 2 without using any adhesive, the separation of the sealing resin coating 4 and the wiring substrate 2 from each other by the shrinkage of an adhesive, when used, bonding the semiconductor IC chip 1 to the wiring substrate 2 caused by a heat shock exerted on the adhesive will not occur and the disconnection of the metal wires 3 from the bond pads of the wiring substrate 2 will not occur.

A tape provided with conductive wires, or wires of a conductive paste may be used instead of the metal wires 3 to connect the bond pads of the semiconductor IC chip 1 to the bond pads of the wiring substrate 2. Generally, such a tape has a thickness in the range of 60 to 200 μ m and hence the thickness 6 of the sealing resin coating 4 may be in the range of about 80 to 200 μ m, which enables the fabrication of a semiconductor device having a further reduced thickness. Wires of a conductive paste are formed in a thickness in the range of 60 to 200 μ m and hence the thickness 6 of the sealing resin coating 4 may be in the range of abut 50 to 220 μ m, which also enables the fabrication of a semiconductor device having a further reduced thickness. Wires of a conductive

paste do not come off the wiring substrate 2 easily because of their large area in contact with the wiring substrate 2.

A method of fabricating the semiconductor device in the first embodiment will be described hereinafter with reference to Figs. 2(a) to 2(e), in which indicated at 8 is an adhesive tape and at 9 is a stage provided with a projection, and parts like or corresponding to those shown in Fig. 1 are designated by the same reference characters.

As shown in Fig. 2(a), an adhesive tape 8 provided with an adhesive layer is attached to the second surface of the wiring substrate 2, and the semiconductor IC chip 1 is inserted in the through hole of the wiring substrate 2 so as to be attached to the adhesive tape 8.

As shown in Fig. 2(b), the wiring substrate 2 is placed on a stage 9 provided with a projection so that the projection of the stage 9 is fitted in the through hole of the wiring substrate 2 to push up the semiconductor IC chip 1 relative to the wiring substrate 2. Since the semiconductor IC chip 1 and the stage 9 have dimensional errors, the front surface of the semiconductor IC chip 1 extends at a height from the front surface of the wiring substrate 2 in the range of 150 μ m.

As shown in Fig. 2(c), the bond pads of the semiconductor IC chip 1 are connected to the bond pads formed at the edge of the wiring substrate 2 by the metal wires 3, respectively.

As shown in Fig. 2(d), the semiconductor IC chip 1 and the metal wires 3 are coated with the sealing resin coating 4. Part of the sealing resin coating 4 fills up gaps between the side surface of the semiconductor IC chip 1 and the side surface of the through hole of the wiring substrate 2.

Finally, as shown in Fig. 2(e), the semiconductor device formed by thus assembling the semiconductor IC chip 1, the wiring substrate 2, the metal wires 3 and the sealing resin coating 4 is separated from the adhesive tape 8 and the stage 9.

Another method of fabricating the semiconductor device in the first embodiment is illustrated by Figs. 3(a) to 3(d), in which indicated at 10 is a stage having a projection provided with an air passage.

As shown in Fig. 3(a), the projection of the stage 10 is inserted in the through hole of the wiring substrate 2, and the semiconductor IC chip 1 is inserted in the through hole of the wiring substrate 2 and is seated on the projection of the stage 10. Since the semiconductor IC chip 1 and the stage 10 have dimensional errors, the front surface of the semiconductor IC chip 1 extends at a height from the front surface of the wiring board 2 in the range of 150 μ m.

As shown in Fig. 3(b), the bond pads of the semiconductor IC chip 1 are connected to the bond pads of the wiring substrate 2 by the metal wires 3, respectively, by a wire bonding process. During the wire bonding process, suction is exerted on the semiconductor IC chip 1 through the air passage to hold the semiconductor IC chip 1 fixedly in place on the stage 10.

As shown in Fig.3(c), the semiconductor IC chip 1 and the metal wires 3 are coated with the sealing resin coating 4. Part of the sealing resin coating 4 fills up gaps between the side surface of the semiconductor IC chip 1 and the side surface of the through hole of the wiring substrate 2.

Finally, as shown in Fig.3(d), the semiconductor device formed by thus assembling the semiconductor IC chip 1, the wiring substrate 2, the metal wires 3 and the sealing resin coating 4 is

separated from the stage 10.

The foregoing methods of fabricating the semiconductor device in the first embodiment connect the bond pads of the semiconductor IC chip 1 to those of the wiring substrate 2 by the metal wires 3. Those methods may use tapes provided with conductive wires or wires of a conductive paste instead of the metal wires 3.

A method of forming wires of a conductive paste will be described hereinafter with reference to Fig. 4, in which indicated at 11 is a wire of a conductive paste and at 12 is a nozzle, and parts like or corresponding to those shown in Figs. 3(a) to 3(d) are designated by the same reference characters. As shown in Fig. 4, the conductive paste is applied to the first surfaces of the semiconductor IC chip 1 and the wiring substrate 2 by the nozzle 12 so as to form wires 11 interconnecting the bond pads of the semiconductor IC chip 1 and the wiring substrate 2.

Figs. 5(a) to 5(c) illustrate another method of forming wires of a conductive paste, in which indicated at 13 is a mask having a pattern of open areas corresponding to a pattern ofwires and at 14 is a squeegee, and parts like or corresponding to those shown in Fig. 4 are designated by the same reference characters.

As shown in Fig. 5(a), the mask 13 is disposed on the wiring substrate 2 so that the open areas of the mask 13 correspond to regions in which wires are formed on the semiconductor IC chip 1 and the wiring substrate 2, respectively.

Subsequently, as shown in Fig. 5(b), a mass of a conductive paste is put on the mask 13.

Finally, as shown in Fig. 5(c), the squeegee 14 is moved along the surface of the mask 13 in the direction of the arrow to spread the conductive paste into the open areas of the mask 13 to form the wires 11. The wires 11 can be formed in a substantially uniform thickness depending on the thickness of the mask 13. The wires 11 can be formed in a desired thickness by selectively determining the thickness of the mask 13.

Figs. 6(a) to 6(d) illustrate a third method of forming the wires 11 of a conductive paste, in which indicated at 15 is a transfer roller and at 16 is a letterpress printing plate, and parts like or corresponding to those shown in Fig. 4 are designated by the same reference characters.

As shown in Fig. 6(a), the transfer roller 15 is rotated in the direction of the arrow, and the letter press printing plate 16 having surface areas coated with a pattern of a conductive paste corresponding to a pattern of wires 11 is moved in the direction of the arrow at a speed equal to the circumferential speed of the transfer roller 15 to transfer a pattern of the conductive paste corresponding to the pattern of wires 11 to be formed on the semiconductor IC chip 1 and the wiring substrate 2 from the letterpress printing plate 16 to the transfer roller 15.

As shown in Fig. 6(b), a stage 10 supporting the wiring substrate 2 and the semiconductor IC chip 1 inserted in the through hole of the wiring substrate 2 presses the wiring substrate 2 against the circumference of the transfer roller 15 and is moved in the direction of the arrow opposite the moving direction of the letterpress printing plate 16 at a speed equal to the circumferential speed of the transfer roller 15.

Consequently, the pattern of the conductive paste is transferred from the transfer roller 15 to the

semiconductor IC chip 1 and the wiring substrate 2 as shown in Fig. 6(c) and the wires 11 of the conductive paste are formed on the front surfaces of the semiconductor IC chip 1 and the wiring substrate 2 as shown in Fig. 6(d).

Second Embodiment

A semiconductor device in a second embodiment according to the present invention is shown in Fig. 7, in which parts like or corresponding to those of the first embodiment are designated by the same reference characters.

The semiconductor device in the second embodiment has a wiring substrate 2 provided with a through hole extending between the opposite surfaces thereof, and two semiconductor IC chips 1 each provided with bond pads on one surface thereof and inserted in the through hole of the wiring substrate 2 in a back-to-back arrangement with the surfaces not provided with the bond pads facing each other. The bond pads of the semiconductor IC chips 1 are connected electrically to the bond pads formed at the edge of the conductive lines of the wiring substrate 2 by metal wires 3. Sealing resin coatings 4 seal the semiconductor IC chips 1 and the metal wires 3 therein and bond together the semiconductor IC chips 1 and the wiring substrate 2. The sealing resin coatings 4 fill up gaps between the side surface of the semiconductor IC chips 1 and the side surface of the through hole of the wiring substrate 2.

The metal wires 3 extend at a height in the range of 150 to 250 μ m, and each of the sealing resin coatings 4 has a height 6 in the range of about 170 to 270 μ m. The thickness 6 is 270 μ m at the greatest.

The bond pads of the semiconductor IC chips 1, similarly to those of the semiconductor device in the first embodiment, may electrically be connected to the bond pads of the wiring substrate 2 by a tape provided with conductive wires or by wires of a conductive paste. When wires of a conductive paste are employed, the same may be formed by the method of forming the wires of the conductive paste previously described in connection with the first embodiment.

The semiconductor device in the second embodiment, similarly to that in the first embodiment, is fabricated by inserting one of the semiconductor IC chips 1 in the through hole of the wiring substrate 2, electrically connecting the bond pads of the semiconductor IC chip 1 to bond pads formed on one of the opposite surfaces of the wiring substrate 2 by the metal wires 3, coating the semiconductor IC chip 1 and the metal wires 3 with the sealing resin coating 4, inverting the wiring substrate 2 upside down, inserting the other semiconductor IC chip 1 in the through hole of the wiring substrate 2, electrically connecting the bond pads of the semiconductor IC chip 1 to bond pads formed on the other surface of the wiring substrate 2 by the metal wires 3, and coating the semiconductor IC chip 1 and the metal wires 3 with the sealing resin coating 4.

The semiconductor device in the second embodiment, similarly to that in the first embodiment, can be formed in a small thickness and permit high-density packaging . Further since two semiconductor IC chips are inserted in the through hole of the wiring substrate,the semiconductor device in the second embodiment has multi-function.

The semiconductor device in the present invention can be formed in a small thickness because

the semiconductor IC chips are inserted in the through hole of the wiring substrate. Since any adhesive is not used for attaching the semiconductor IC chips to the wiring substrate, the bond pads of the wiring substrate need not be separated far from the edges of the semiconductor IC chips to avoid being covered with an irregularly spread layer of an adhesive. The bond pads of the wiring substrate may be formed at positions close to the edges of the semiconductor IC chips. Accordingly, the semiconductor device can be formed in a small area, which enables high-density packaging.

The foregoing embodiments of the present invention are illustrative and not restrictive. It is obvious to those skilled in the art that various changes and modifications are possible in the foregoing embodiments without departing from the scope and spirit of the invention. The scope of the invention, therefore, is to be determined solely by the following claims.